Maine Agricultural Experiment Station

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THE POTATO PLANT LOUSE.

This bulletin contains an account of the potato plant louse which has infested Maine potato fields the past few years.

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BULLETIN No. 147.

THE POTATO PLANT LOUSE.

Nectarophora solanifolii Ashmead.

EDITH M. PATCH.

On account of their extremely small size, aphids or plant lice are to a great extent unnoticed, but when conditions are favorable to their increase there are many species of these minute creatures that are capable of bringing devastation to the vegetation which they frequent and staple crops often suffer severe attacks. The hop plant louse, the several aphids of the apple, the spring grain aphis, the corn aphids, the melon aphis, are, for instance, pests of tremendous importance; and the destructive green pea louse alone is estimated to have caused a loss of $7,000,000 during the two seasons of 1899 and 1900 just along the Atlantic Coast States. During the past 4 years many species of aphids representing 14 genera and living upon about 90 species of plants and trees have been collected for the Maine Agricultural Experiment Station and some few of these have been given special study. Of these the potato plant louse, attacking as it does one of our chief crops in Maine, and presenting in its life history certain points which may be of significance in connection with closely related species, has seemed of sufficient importance to record somewhat fully.

ECONOMIC SIGNIFICANCE.

During the summers of 1904, 1905 and 1906, enormous numbers of the plant louse, *N. solanifolii,* appeared over wide areas in Aroostook County, the potato vines being attacked to an injurious extent in the vicinity of Houlton and elsewhere. The colonies cluster thick on stem, leaf and blossom stalk, blighting

the stems and drying the terminal leaves. See Fig. 25. The time of severest attack apparently varies somewhat, but the infestation for the past 3 years in Maine has not been excessive before early August and is entirely over with before the middle of September. Under conditions favorable to Aphid growth, an attack of less than 2 weeks' duration suffices to kill the potato stalk for a distance from 4 to 6 inches from the tip, and the growth of the tubers on plants thus weakened must necessarily be affected. Aside from the direct weakening of the plant due to the loss of sap and the withering of the tissue, the danger to the health of a plant thus attacked by plant lice is considerable. Although exceedingly minute, the beak of the plant louse makes a wound which becomes in a short time surrounded by a discolored area, readily detected by the unaided eye. As these wounds extend for some little distance into the plant, a favorable location for the entrance of bacterial or fungus disease is thus secured even where the infestation of plant lice is not excessive enough to wither the tips of the stalk. Moreover it is perfectly possible for insects to carry fungus spores from diseased to healthy plants. Where the plant lice are abundant the leaves are covered with honey dew which is soon attacked by a dark fungus, and which together with the molted skins adhering to the sticky substance, gives the leaves an unhealthy appearance and must interfere with their natural function.

The same species has at times been extremely abundant upon the potato in Canada and the following quotation from Doctor Fletcher's report for 1904 is of interest in this connection both because of the seriousness of the infestation and the fact that the time of appearance at Mahone Bay where the observations were made was earlier than it has been in Maine.

"Potato Aphis (*Nectarophora solanifolii*, Ashm.).—Potatoes are not often troubled with plant lice in Canada; but at long intervals outbreaks have been observed on this crop, and such a one occurred last summer at Mahone Bay, which was closely watched by Doctor Hamilton.

'Mahone Bay, June 28.—I send you some aphides from potatoes which are abundant enough to have appreciably blighted my potato plants.'

'July 10.—The aphis on my potatoes has overrun the whole patch, with the result that the potatoes have stopped growing and look very unhealthy. The blossoms have withered up and fallen, the lower leaves have turned yellow, and many others have turned black, just as if smitten with the blight, and are falling. They occur in immense numbers. Their

favorite position is upon the peduncles of the flowers, which they cover completely. They are also found in large clusters on the stems and upon the under surface of the leaves. In many colonies there are a few flesh-colored individuals.'

'July 16.—The plant lice on the potatoes are fast diminishing in numbers; but they have left the crop in a sorry condition.'

'August 1.—I send you today a last specimen from my potato plot. They have evidently been killed by a fungus. I first noticed its effects about a week ago on one corner, and it has since spread over the whole piece. Very few aphides are left alive. Since I last wrote, I noticed larvæ of lady bird beetles and of *Syrphus* flies; but neither of these or anything else had much effect in reducing the numbers of the plant lice until this disease appeared. A month ago my potatoes could not have looked more promising. Today I tried them, and out of 6 average hills I got 17 tubers, of which 2 only were large enough to be marketed.' —C. A. Hamilton."

In view of so extended and injurious an infestation of one of the chief crops of Maine for 3 consecutive years, it seemed desirable to ascertain whether there might not be some practical method of treatment or prevention. The standard remedy for plant lice—kerosene emulsion or whale oil soap spray—did not seem advisable for several reasons. By the time the plant lice have colonized the vines to an extent great enough to be particularly noticeable, the damage is already half done and the winged generations which develop at the time the potato tops grow sickly, leave the plants they are on for fresh vegetation. The proposition of spraying 40 acres of potato vines with kerosene emulsion late in August for instance when the wing pads which bespeak the migrating generation are already in evidence would not appeal to the large potato grower. To apply such a spray before the infestation became excessive, while it would kill many of the scattered plant lice, might on the other hand be a sheer waste of energy, for the amount of injury which plant lice are going to inflict is a matter not fairly open to prophecy, so many elements of uncertainty enter in. The weather, for instance, plays an important part in the welfare of plant lice, heavy rains washing the tender forms from the plants, and cold days retarding the rate of increase. A long stretch of damp weather is favorable to fungus parasitism which may sweep out the plant lice from a large area. Then, too, in certain seasons, predaceous and parasitic insects appear in numbers sufficient to render any artificial remedial measures

superfluous. The efficiency of emulsion sprays for plant lice has too long been known to make plausible any attempt for any other direct treatment in this case. But to be successful an emulsion spray since it kills by contact would need to be forced under the infested leaves as well as along the tip of the stem and between the buds and flowers where the plant lice are particularly crowded. Just what the results of such a treatment upon the potato might be is a problem which concerns the plant pathologist, and while the fate of the insects subjected to such a treatment would be satisfactory to the potato grower, whether the fate of the vine would be equally so is a matter which would require careful tests to decide.

The standard remedy for plant lice, in short, seemed not available for the situation in question.

The alternative was the study of the life history of this species with a view of ascertaining the alternate host plant and if practicable eradicating it or controlling its growth within the vicinity of potato fields.

A Generalized Life Cycle for Nectarophora.

In order to outline the need of such a study with a given species of plant louse whose life history is not known, the life cycle of plant lice in general is here briefly sketched. Although the life cycle varies greatly within the range of Aphididæ, the family of plant lice, the following are the points drawn from related forms which seemed of significance with the life cycle of *N. solanifolii* in view.

In the north such a plant louse may be expected to winter in the egg stage. From the egg emerges in the spring a wingless form which is commonly spoken of as the stem mother. The stem mother does not deposit eggs but produces living young, and is the first of a long series of forms designated on this account as viviparous females. The young plant lice begin at once to feed upon the sap of the plant and in 8 or 10 days produce offspring. The first few spring generations may be wingless or at any time winged individuals or an entire winged generation may appear and fly away to fresh plants and there start new colonies where a succession of generations are produced as before. Such a winged generation is called the

migrant generation and with many species the migrants desert the host plant upon which they have been feeding and seek a plant of an entirely different species. Thus the plant louse destructive to hops passes part of its life cycle upon plum trees. This alternation of hosts is a point in the life history of Aphididæ of great economic significance, for it sometimes happens that a species can be controlled on one plant and thus its attack upon the alternate host be prevented.

After spending a few weeks or a few months upon the second host plant, winged individuals called fall migrants appear and return to the same kind of plant, the winter host, upon which the stem mother and the spring generations had lived, and there continue the series of generations. Up to this time no males have appeared and all of the forms, whether winged or wingless, have been females giving birth to living young as was the case with the "stem mother." But after the fall migration they are likely to develop the true sexes, males and egg-laying females. These oviparous females deposit a few comparatively large eggs, in which stage the insect winters and from which the stem mothers hatch in the spring.

It is some such outline as the foregoing to which a species whose life history is unknown must be referred as a working basis. Any variation of the general life cycle of the plant lice, however, is never a fair cause for surprise. One is quite likely to find, for instance, that a certain species does not pass the winter in the egg stage but as a subterranean form at the roots of some plant.

The difficulties as to life history studies presented by the alternation of host plants common among the Aphididæ are augmented by the fact that certain differences in structure, great enough to count as specific if occurring in other families of insects, are common in different generations of a single species of plant louse. It not infrequently happens, therefore, that the same species may, when found upon different host plants, be recorded as two or more distinct species and their identity not suspected for years. Also, 2 actually distinct species may resemble each other so closely in certain forms that they are easily mistaken for one species. Moreover the specific characters of the genus Nectarophora have not been systematically determined.

Any work, therefore, either systematic or ecological, undertaken with this genus should be pursued with the idea that it shall in some way lessen instead of augment the confusion which already exists with this group of plant lice. The observations recorded for *N. solanifolii* in the present bulletin are meagre but they all unquestionably refer to the single species under consideration. It seems advisable to tabulate such facts as have been ascertained now rather than to wait for the accumulated observations of a longer period for 2 reasons. The economic point involved—that is, whether *N. solanifolii* might practically be combated upon its winter host—seems to be answered by the evidence now at hand. Then, too, over those parts of the State which were under observation this season, *N. solanifolii* upon the potato was apparently so nearly exterminated by fungus parasitism that it is probable that some time will elapse before this species again appears in the State to an extent great enough to make further work with it practical.

Nectarophora Solanifolii from Field Observations.

The points which were evident for this species in Maine from field observations upon the potato for the 3 seasons 1904-1906 were that about the middle of July a very few scattered individuals may be seen upon the potato; that before the last of August the infestation may become excessive, the tips of the stalks, flower stems and terminal leaves being packed with plant lice; that by the middle of September the fall migration is over; and that the migration takes place before the true sexes appear, neither the oviparous female nor the male occurring upon the potato in the field. The points in the life history which were not known and concerning which it was desirable to obtain data were upon what plant the spring generations lived; whether this Nectarophora would accept more than one host beside the potato (that is, whether it was a "general" or a "specific" feeder); whether the true sexes appeared in the fall, and if so where the eggs were deposited.

A few dates may be quoted here for instance.

August 11, 1904, Houlton.—A correspondent who had been much worried by a bad infestation sent in a box of *N. solanifolii* mostly winged or within one molt of being winged with the comment: "I do not find

nearly so many on my vines as I did a week ago. The blossoms are about all gone from my potatoes and the small stalk on which the blossoms grew is a dirty brown color and seems to be withering up."

August 17, 1905, Houlton.—The writer found *N. solanifolii* excessively abundant over about 20 acres. The stalk tips were crowded with viviparous forms both winged and wingless, and in many cases the flower stalks were dead.

August 25, 1906, Houlton.—Potato stem tips and leaves literally packed with *N. solanifolii*. Much injury to the potato tops evident.

July 18-19, 1906, Houlton.—A 2 days' careful search in 4 large potato fields (one of which is the field for which the foregoing record of August 17, 1905, is made) resulted in the finding of but one specimen of *N. solanifolii*. That single specimen was a wingless form and there were 3 lady-beetles after it.

July 18, 1907, Houlton.—A large field that had been heavily infested the previous August was examined. A very few scattered individuals were found on the blossom stalks of potato. A most thorough search for some distance over many rows revealed not more than an average of a single specimen to 3 rods. These were wingless viviparous forms sometimes apparently still too young to start a colony and sometimes mature and accompanied by a very few progeny. No winged form was seen on this date.

July 24, 1907, Kennebunkport.—*N. solanifolii* present upon potato but very scattering and chiefly wingless. A single winged specimen taken.

July 25, 1907, Farmington.—*N. solanifolii* present upon potatoes but very much scattered.

July 31, 1907, Houlton.—(Same field as foregoing record for July 18, 1907). *N. solanifolii* nowhere numerous, yet present all over the field. A single wingless, viviparous form with progeny on every third and fourth hill and winged viviparous forms with progeny found here and there, but less common than the wingless forms. A few individuals whose wing pads indicated they were but one molt from maturity taken on this date would indicate that these winged forms present did not come as migrants but had developed as progeny of the wingless forms noticed earlier in the month.

September, 1906, Houlton.—Early in the month the fall migrants acquired wings and deserted the potato. On September 14 only 4 or 5 belated specimens were found in a day's search in several fields where the infestation had been excessive in August. No males or oviparous females were seen upon the potato in the field during the 3 years though frequent searches were made. Although the infested fields were visited once or twice weekly for nearly the entire season, further quotations from the field notes for 1907 are omitted here because on account of continuous and heavy rains the species were held much in check and also because later practically the whole infestation was killed out by a fungus parasite, the natural increase of the species being prevented by either cause enough to make the field notes for the present year exceptional rather than the rule.

Insectary Observations.

During the summer of 1906 this species was bred in the insectary upon potato, but as various other species were under observation in the same house and as two species of the genus Aphis colonized the potato there to an extent which interfered with the work with *N. solanifolii,* little reliable data was obtained. For the season 1907 particular precautions were taken. During the entire summer no plants were grown in the insectary except such as were started there from seed—that is, no risks were taken as to the introduction of any other species of plant louse upon plants. A single exception was made when the house was stocked with shepherd's purse, but for this purpose very young plants were used and these carefully examined. It should be stated that during the entire time of the observations upon these plant lice the insectary was not heated in any way, so that the temperature conditions were not so widely different from those out of doors, that this element need come in for consideration. It was, however, possible for the insectary colonies to breed unchecked by rains, predaceous or parasitic insects, though a fungus parasite was introduced in August which seriously interfered with the uncaged material.

The few specimens obtainable (see field notes for Houlton, July 18, 1907) were placed upon potato plants in cloth cages in the insectary July 19; July 22 they were increasing rapidly, many had molted and all seemed healthy. Some such interesting data were obtained from the material started at this time that quotations from notes made upon them are here included. These specimens and their descendants, caged in cloth cages from July 19 to September 20, were protected during the entire time from the fungus which was introduced in August with uncaged material and which spread through the insectary.

August 3, 1907. Insectary.—The progeny of the wingless viviparous lot taken at Houlton July 18 are winged viviparous forms. The stalks this lot have been colonizing since July 18 are speckled with beak wounds. The plants have a general unhealthy appearance and the leaves are sticky with honey dew and somewhat attacked by honey dew fungus.

These winged individuals left the sickly potato stalks upon which they had fed during the earlier stages of their lives and rested upon the cloth sides of the cage which confined the potato. These winged forms were removed from the cloth and placed in lots of 20 each under cages upon fresh potato previously uninfested. They settled at once, remaining upon the fresh stalks.

August 5. None of the transferred specimens have left the new plants. They are feeding and producing young actively and not a single individual is to be seen upon the cloth of these new cages, all signs of the restlessness evinced in the old cage having left them. It seems reasonable to suppose that their desertion of the plants upon which they had been reared was caused by the unhealthy condition of these plants due to the two weeks presence of the plant lice. Provided with fresh plants they were content. It is probably due to this migrating instinct that makes possible the even infestation of a whole potato field,—the first winged forms developing upon stalks over crowded and consequently sickly, seeking uninfested tips for their own feeding places and for their progeny.

August 13. The progeny of the foregoing winged viviparous forms are partly wingless viviparous forms and partly, as indicated by wing pads, to be winged viviparous forms. The colonies do not seem particularly vigorous. The plant tips are badly speckled with beak wounds and the leaves a little discolored with honey dew fungus.

September 20.—The material recorded August 3 and August 13 was in the case of 2 cages left unmolested until today when both the true sexes are found to be present. The males are winged. The females are wingless. Further description of these forms is reserved for another place.

September 21.—About 8 males and some 20 oviparous females were removed from the potato and placed upon a young shepherd's purse plant in a cloth cage. Females were added from time to time and a very few males. From September 21 to October 11 from one to 3 pairs of these were noticed in copulation each day. On October 11 examination of the sheperd's purse showed Nectarophora eggs variously placed on the upper and under sides of the leaves and along the stem. One was deposited on a cheese cloth thread in the cage.

It should be emphasized here that although the true sexes developed upon the potato in the insectary and thereby showed that another plant was not a necessity for these forms, the situation was practically forced. A single caged potato plant had been stocked August 3 with 20 winged viviparous forms reared on potato from the wingless viviparous forms collected July 18 and left to them and to their progeny until September 20, there being no choice for the prisoners except the potato or death, for a period of 2 months. This period extended considerably past the season of migration for *N. solanifolii* in the field which had been observed to have occurred for 3 years early in September or late in August. The fact that the imprisoned insects then developed the true sexes upon potato is no indication that such would be the case in the open field. Indeed the fact that the true sexes did not appear until long after the season of out-of-door migration would rather indicate

that normally the winter host plant would be sought previous to the appearance of the males and oviparous females.

The objection that such forced conditions might have no bearing upon the normal development in the field might be a legitimate one except for the observations taken as a check upon material during this same time that had the liberty of the whole insectary and a choice of host plants. These observations are as follows:

August 16 about 80 perfectly healthy potato plants in the insectary were stocked with *N. solanifolii* collected at Orono and were left uncaged. By August 30 they were fairly represented by the photograph (Fig. 26) taken at that time. Later the stalks in most cases died to the ground and new shoots started up from the base. By planting potatoes in the insectary often the plant lice were kept supplied with fresh plants which were colonized by the individuals which deserted the plants they had rendered sickly.

August 31, 1907, Houlton, Maine.—In a buckwheat field adjacent to a potato field several colonies of *Nectarophora* sp. were to be found upon buckwheat tips. They were in all respects discernable by a hand lens the same as *N. solanifolii.* Both green and pink color forms were present but they were so seriously fungus attacked that by the time even the healthiest of the specimens could be brought to Orono, microscopic examination for comparison with *N. solanifolii* was unsatisfactory and breeding for winged forms was impossible.

August 31, 1907, Houlton, Maine.—From shepherd's purse *Capsella Bursa-pastoris* Moench. several colonies of *Nectarophora* sp. were taken. They were not to be distinguished from *N. solanifolii* by hand lens examination and both green and pink color forms were taken. They were badly attacked by fungus and by the time they reached Orono they were in no condition for further observations.

The suggestions given by these two collections was acted upon conversely, however, by sowing buckwheat among the potato plants in the insectary and transplanting about 200 young and clean plants of shepherd's purse into trays. Peas were also sown at the same time. By the time the buckwheat and peas were well up about 100 fresh potato plants were available, and the *N. solanifolii,* deserting the older potato stalks, colonized thoroughly the fresh potato vines, pea vines, and the shepherd's purse apparently with no preference. Both winged and wingless forms were found for the rest of the season rearing contented progeny upon potato, and shepherd's purse, and also upon the young pea vines until they killed them. Except for stray individuals which, of course, would be found upon everything in the crowded insectary, the buckwheat remained apparently untouched. Whether *N. solanifolii* would have accepted the blossom tips of the older buckwheat or not was not demonstrated as the buckwheat, although it lived, did not make much growth.

From the last of July, 1907, to October 11 (possibly later) both winged and wingless viviparous forms were present in the insectary. With the Orono material of August 16, individuals attacked by a fungus were inadvertably introduced, and the fungus spread among all the uncaged material keeping it so reduced in numbers there seemed danger of the insectary observations meeting the same fate as those of the field. However, every opportunity by way of freshly planted material was given them and the insectary was kept as dry as possible and enough of the plant lice escaped the fungus to keep the situation interesting.

September 23. After finding the true sexes upon the caged material, careful canvass was made of the uncaged plants in the insectary and numerous oviparous females (mostly still young) were found both upon the potato and shepherd's purse, although more numerously upon shepherd's purse. No males were found at this time and later but two were seen in copulation on the uncaged material,—one pair being upon shepherd's purse and one upon potato. The prevalence of the fungus undoubtedly prevented the development of a greater number of the true sexes.

October 11. Insectary search showed the *Nectarophora* eggs near some of the oviparous forms both upon potato and shepherd's purse. Many of the eggs were the glistening brownish black of well hardened eggs but some were pelucid green showing that they had very recently been deposited. They were upon the plants indiscriminately on leaves and stalks.

The appearance of the oviparous females and the deposition of eggs with the uncaged material at practically the same time as that of the forms that had been prisoners for 2 months would indicate that these dates are about normal. In the insectary the migration from overcrowded potato stalks to fresh plants seemed to take place irregularly and not at any stated times, the condition of the infested plant apparently influencing these movements. The fact that they seemed to seek the fresh potato plants almost as readily as the peas or the shepherd's purse might seem to indicate that if a similar succession of new potatoes were supplied them in the field they might not seek another host even there. As it is a wholesale migration has taken place each of the 3 seasons these plant lice have been under observation.

It seemed reasonable to expect that such an enormous number of healthy plant lice as had migrated from the Houlton potato vines late in the summer of 1906 might with careful search be located on the alternate host. After several long and tedious attempts during September, 1906, the writer, somewhat chagrined, postponed the search until the following spring in

hopes of finding them before the spring migration. During June and July, 1907, (until *N. solanifolii* appeared upon the potato) the search was continued until it seemed as though every species of vegetation within aphid flight of potato fields had been examined, but no *N. solanifolii* were chanced upon.

Two conditions noted July 18, 1907, were of considerable consolation in this connection. The first specimens observed on the potato at the date were very few—one to about 3 rods—a circumstance that might seem to indicate that the species was not numerous enough upon anything to make a wholesale migration necessary. A more puzzling fact was that the first forms seen were wingless and solitary except for their own progeny, and many of them had not yet begun to produce. There was in this no basis for suspecting that any migration in the usual sense, that is of a horde of winged forms, had taken place, but rather that restless individuals had crept over on to the potatoes from neighboring vegetation. No conclusive statement, of course, would be justifiable upon observations so limited, and these suggestions relative to the manner of migration are merely tentative. Insectary observations showed this species to be active and restless at times both in the winged and young apterous forms.

The Practicability of Combating N. Solanifolii Upon Its Winter Host.

Since for several consecutive seasons of excessive infestation of the potato, *N. solanifolii* has while upon its winter (and consequently late fall and early spring) host lived in such restricted numbers that it was, to say the least, nowhere conspicuous, it is evident that any measure directed against this species while upon its winter host is for Maine quite futile. The readiness with which the insectary material accepted pea vines and shepherd's purse lays this species open to the suspicion of not being confined to 2 hosts for Maine. Further tests as to the wider range of food plants would be of much interest and there is a possibility that a complete food list would contain some helpful suggestions. Insectary tests as to a wide range of food plants are contemplated as a part of the further study of this species. As an example of the possible significance of fuller host plant data may be cited the following

observation. After the insectary material was found to accept pea vines for colonization, the fact that it is the custom in Aroostook County to plant peas with oats as a part of the crop rotation including the potato was remembered. These pea vines are, of course, sheltered by the oats and as they are cut merely for fodder a summer infestation of aphids would, unless especial search was made, pass undetected.

In the vicinity of Houlton, September 11-September 16, 1907, search on the peas growing with oats was made and both winged and wingless forms of *Nectarophora* sp. apparently like *N. solanifolii* were found. Like the *Nectarophora* upon potato, shepherd's purse, and buckwheat, the species upon peas was too badly attacked by fungus to render much work with it possible.

In view of the fact, however, that the species upon the potato will feed and multiply readily upon pea vines (see insectary notes) it might be advisable, if the trouble continues to be seriously prevalent, to omit the peas from the rotation scheme. For potatoes upon numerous 20 to 60-acre fields one year and peas over the same area the next would seem to offer an unbroken opportunity for the growth of the summer generations of this destructive plant louse. This suggestion does not touch the question of the winter host, because it would be upon these vines as upon the potato that the summer generations would occur, and even if eggs were deposited upon the pea, as it is harvested with the oat crop it could not serve as a dangerous winter host.

Summary as to Remedial Measures.

1. The standard remedies for plant lice, emulsion sprays, do not seem practicable for the large potato crop of Maine.

2. No other direct remedy seems to be more available.

3. It is apparently futile to attempt to combat this species in Maine through the medium of the winter host.

4. Clean culture may legitimately be classed among the available preventive measures with this pest as with most crop pests. Since it has been ascertained that *N. solanifolii* passes the winter in the egg stage and that the eggs are attached to the leaves of its host, shepherd's purse and possibly various other

weeds, the practice of fall plowing commends itself in this connection and also the burning over of grassy and weedy spaces in the vicinity of potato fields. As it seems not impossible, although it has not been observed, that belated specimens might under certain conditions remain upon potato vines slightly infested and the oviparous females develop there, the custom common through Aroostook County of burning the old potato stalks to get them out of the way is commendable as a precaution.

5. If *N. solanifolii* continues to be a serious pest upon the potato it may be advisable to drop the peas from the rotation.

6. While under favorable conditions *N. solanifolii* is a serious pest upon the potato, there seems to be nothing better to advise by way of direct remedy than to leave it to its natural enemies, which sometimes, as the fungus of this present season, serve practically to exterminate it over wide areas.

7. The countless beak wounds inflicted upon the stalk and leaves must render the potato more susceptible to fungus and bacterial disease. Its presence, therefore, should emphasize the need of careful Bordeaux sprays.

Natural Enemies.

1. Weather conditions stand high among the controlling influences of aphid growth, heavy or continuous rains serving as a check.

2. Predaceous insects. Among these found feeding upon *N. solanifolii* in Maine may be mentioned 2 lady beetles, *Adalia bipunctata* and *Hippodamia 13-punctata,* and larvæ of syrphus flies.

3. Parasitic insects. Braconid parasites of the subfamily Aphidiinæ have been bred from *N. solanifolii* taken in this State.

4. Fungus parasites. Frequent mention has already been made in this bulletin of the work of fungus upon *N. solanifolii* at Houlton and also at Orono whence it was introduced into the insectary. Dead specimens from both localities were submitted to Doctor Roland Thaxter, who kindly identified the Orono species as *E. planchoniana* Cornu, and that from Houlton as the more common *E. aphidis.*

Fig. 25. N. solanifolii on potato stalk. Leaves covered with honey dew, honey dew fungus, and cast skins.

Fig. 26. Potato plant showing the result of 14 days infestation of plant lice on perfectly healthy stalks.

Description of Nectarophora Solanifolii Ashmead.

It will be evident to anyone interested in Aphididæ that *solanifolii* is quite possibly open to the synonomic honors so common to the genus *Nectarophora*. As the question cannot be satisfactorily settled for this species without straightening out *N. pisi* (!) and perhaps all the other nondescript green and pink *Nectarophora*, the writer modestly though regretfully refrains from offering any elucidating suggestions, at present. Utmost care has been taken and will be taken in the future work proposed for this species, to be positive that the data recorded for *N. solanifolii* refers to one species only so that at least it may be certain that the observations add nothing to synonymic confusion.

A considerable mass of mounted material of this species collected during 1904-1905 was kindly determined through the courtesy of the U. S. Bureau of Entomology by Mr. Pergande as *Macrosiphum (Nectarophora) solanifolii* Ashmead. Doctor Fletcher acknowledges the same authority for the name of the species abundant upon potato in Canada mentioned in his report for 1904.

The original description made for specimens found on *Solanum jasminoides* for this species appeared in the Canadian Entomologist, Vol. 14, 1882, pages 92-93, and may be quoted for the apterous viviparous form:

"*Siphonophora solanifolii* n. sp.

"Wingless female.—Length .12 inch. Elongate ovate and of a pale yellowish green color; beak short, not reaching middle coxæ, pale, tip black; antennæ 7-jointed, slightly reaching beyond abdomen, situated on large tubercles, pale greenish, joints infuscated, 6th joint shortest, dark, 7th longest, brown; eyes red; honey tubes very long, reaching considerably beyond abdomen, slightly thickened at base, infuscated at tip; style short, conical, greenish, coxæ shining and yellowish, feet black."

Mistake as to the identity of the so-called male is evident from the original description of this form and is therefore omitted. "Antennæ hardly reaching to middle of abdomen" and "honey tubes rather short" could not, in light of further acquaintance with this form, be expected to apply to a male of the genus under consideration.

In general *N. solanifolii* is a large, active species, usually green but very often pink, and sometimes yellowish, especially the young of the pink individuals.

Decidedly pink individuals occur both with the winged and apterous viviparous females. At Houlton, August 17, 1905, a pink-winged viviparous female was taken with 12 young, 7 of which were decidedly green and 5 decidedly pink. About 20 pink viviparous specimens collected at Maple Grove, August 18, 1906, were placed upon potato in the insectary. Some were winged and some were apterous. On August 29 the young of these were all found to be pink, though many were toning into pale yellow.

The insectary specimens of oviparous females were largely pink, though many were yellow, and a few distinctly green.

NECTAROPHORA SOLANIFOLII. *Winged viviparous female.*—Head yellowish green. Antennæ, proximal segments pale green, distal segments dark; length of segments: III, .88 to .96 mm.; IV, .76 to .9 mm.; V, .64 to .72 mm.; VI, .16 to .2 mm.; VII, .96 to 1.12 mm.; total length I to VII, 3.6 to 4.05 mm. Prothorax and thorax light yellowish green. Wings hyaline, veins dark brown, very slender, stigma pale brown. Total wing expansion 8.1 mm. Legs with proximal part of femora and tibiæ pale, tarsi and distal part of femora and tibiæ dark. Tarsi .16 to .2 mm. Abdomen light green unmarked dorsally or ventrally. Cornicles, with proximal portion green, and distal portion dark brown, inbricated, cylindrical, length .95 mm. or about 5 times length of tarsus. Style light green, ensiform, length .48 mm. or about one-half length of cornicles.

Total length of body to distal tip of style and exclusive of antennæ, 2.9 to 3.37 mm.

Winged viviparous female, pink individual.—Head light yellowish. Antennæ with I and II light yellowish, rest dark. Prothorax and thorax light yellowish pink. Abdomen pale pink. Cornicles light yellow with tips dusky. Style pink.

Apterous viviparous female.—Color as with the winged viviparous form. Antennæ, length of segments: III, .8 to .96 mm., IV, .72 to .88 mm., V, .56 to .72 mm., VI, .16 to .2 mm., VII, .96 to 1.2 mm.; total length of segments I to VII average about 4.05 mm. Cornicles .96 to 1.04 mm. in length. Style .56 mm.

Total length of body to distal tip of style and exclusive of antennæ, 4.05 mm.

Apterous oviparous female.—Head pale, nearly white. Antennæ with proximal joints pale, distal half dark. Length of segments: III, .68 to .88 mm.; IV, .56 to .68 mm.; V, .52 to .64 mm.; VI, .16 mm.; VII, .96 to 1.04 mm.; total antennæ length I to VII average about 3.6 mm. Prothorax and thorax pale like head. Legs with femora and tibiæ, proximal portion pale, distal portion dusky. Tarsi dark, .16 mm. long. Hind tibiæ conspicuously darker and much swollen and thickly set with senoria. Abdomen light salmon pink. Cornicles pale at base, distal half dark; length .6 to .8 mm. Style salmon pink, ensiform, length .32 to .4 mm. Total body length to tip of style, antennæ excluded, 2.13 to 2.15 mm. The size of the hind tibiæ of this form makes it readily distinguished from the apterous viviparous form and young, even to the unaided eye.

The pink variety has been described because these predominate. The color scheme of the green and yellow forms can be determined merely by substituting these colors for the salmon pink of the individual described, the dark coloration being the same for all 3.

Winged male.—Head and antennæ dark brown. Length of antennal segments: III, .72 to .8 mm.; IV, .48 to .64 mm.; V, .48 to .6 mm.; VI, .16 mm.; VII, 1.04 to 1.28 mm.; total antennal length I to VII, 2.93 to 3.60 mm. Prothorax and thorax dark brown. Wings deflexed, hyaline, veins dark and very slender, stigma pale brown. Legs brown, darker at tips. Abdomen brown. Cornicles pale brown, dark distally, cylindrical, .48 to .56 mm. long. Total body length exclusive of antennæ and cornicles, 1.12 to 1.57 mm. The thorax is large and strong to support the wing muscles, the abdomen much shrunken and is rendered conspicuous only by the comparatively (for the size of the body) long cornicles. The male is described from specimens observed in copulation, in order that no mistake as to the identity of the species might occur.

Explanation of Plates.

It will be seen from the accompanying camera lucida drawings that *N. solanifolii* is a fairly typical *Nectarophora* as regards antennæ. Although the number of sensoria varies somewhat within the limits of each of the four forms, the segments figured are representative. The antennæ of the apterous viviparous and oviparous females most closely resemble each other, segment III sometimes having 4 sensoria for each form, though the number is more commonly as figured. The number of sensoria is not constant for the winged viviparous form, there frequently being a few more than occurred in the specimen drawn, but they are in all cases arranged in a somewhat irregular row. As is usual for Aphididæ the antennæ of the males are conspicuous for the great number of sensoria present, giving a very uneven outline. Segment V characteristically bears sensoria not found in the other sex. Although the antennæ of the male are not actually so long as those of the females, they are, relative to the total length of the body, much longer, being in this sex more than twice the length of the body.

Fig. 27, winged viviparous form, Antennal Segment III.
Fig. 28, apterous " " " " III.
Fig. 29, apterous oviparous " " " III.
Figs. 30 and 31, winged male, Antennal Segments III, IV, V.
Fig. 32, viviparous form, Basal ⅔ of hind tibia.
Fig. 33, oviparous " " ⅔ " " "

Fig. 27.

Fig. 28.

Fig. 29.

Fig. 30.

Fig. 31.

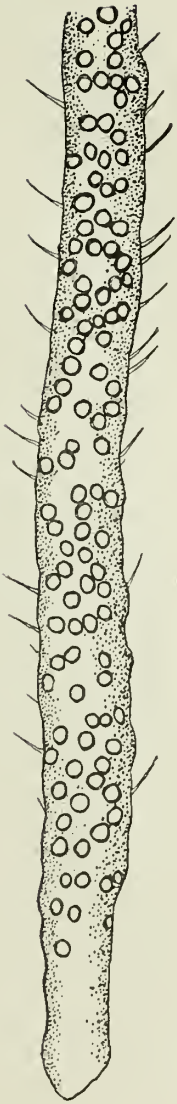

Fig. 33.

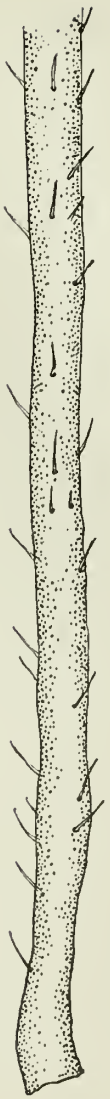

Fig. 32.